AzMERIT | Arizona's Statewide Achievement Assessment for English Language Arts and Mathematics

Math Item Specifications

HIGH SCHOOL (FUNCTIONS)

Arizona Department of Education with American Institutes for Research - 2016

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Introduction

The Arizona Statewide Achievement Assessment for English Language Arts and Mathematics (AzMERIT) is Arizona's statewide achievement test. AzMERIT assesses the Arizona College and Career Ready Standards (AzCCRS) adopted by the Arizona State Board of Education in 2010. AzMERIT will inform students, teachers, and parents about preparedness for college and careers upon graduating from high school. AzMERIT tests are computer-based, meaning that they can better assess students' critical thinking skills and provide them with opportunities to demonstrate a deeper understanding of the materials. Computer-based testing also allows for the use of a variety of innovative items types.

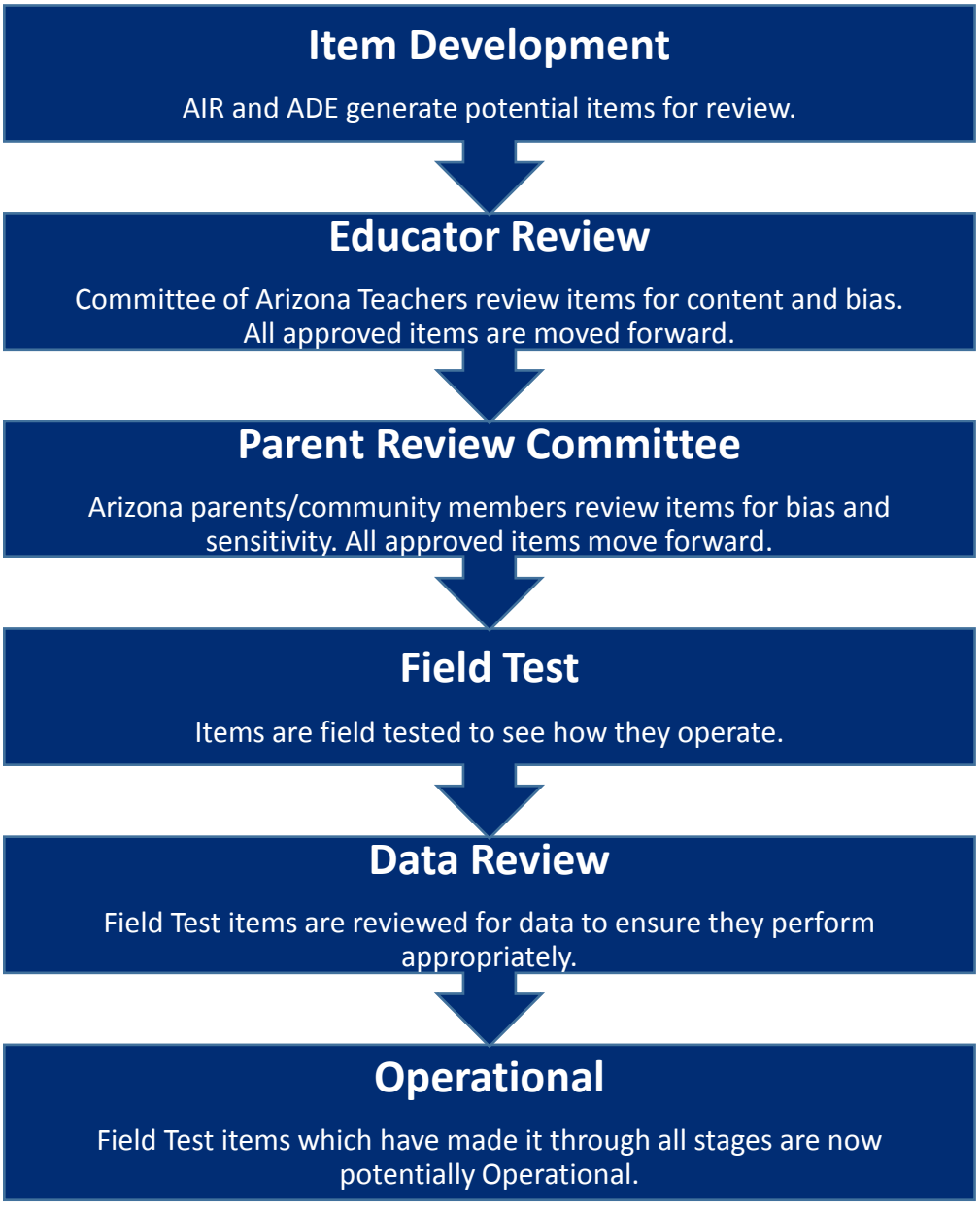
During the item-development process, all AzMERIT items are written in accordance with the Item Specifications and are reviewed and approved by a committee of Arizona educators to confirm alignment and appropriateness for inclusion in the test. AzMERIT items are generally representative of Arizona's geographic regions and culturally diverse population. Items are reviewed for the following kinds of bias: gender, racial, ethnic, linguistic, religious, geographic, and socioeconomic. Item reviews also include consideration of issues related to individuals with disabilities. Arizona community members also have an opportunity to review items for issues of potential concern to members of the community at large. Reviewers are asked to consider the variety of cultural, regional, philosophical, political, and religious backgrounds throughout Arizona, and then to determine whether the subject matter will be acceptable to Arizona students, families, and other members of Arizona communities.

This *AzMERIT Item Specifications* is a resource document that defines the content and format of the test and test items for item writers and reviewers. Each *Item Specifications* document indicates the alignment of items with the AzCCRS. It also serves to provide all stakeholders with information about the scope and function of assessment items. This document can also serve to assist educators to understand how assessment items are developed in alignment with the standards for English language arts and math. These item specifications for AzMERIT are intended to provide information regarding standards, item formats and response types. The descriptions of math practices, blueprints, and depth of knowledge in this document are meant to provide an overview of the test. Item specifications are meant for the purposes of assessment, not instruction. They are not intended to be tools for instruction or the basis for curricula. AzMERIT has a test blueprint that was developed by Arizona and is different from any other state or consortium test blueprint.

For the math portion of AzMERIT, all of the test questions are aligned to the mathematic content standards for these subject areas. Similarly, each item assesses a single domain and aligns to one or more of the eight Math Practices. Any item specifications that are absent for standards listed in this document may be under development. This document does not endorse the exclusion of the instruction of any grade-level content standards. The test will ask questions that check a student's conceptual understanding of math as well as their procedural skills. These items have been written to be free from bias and sensitivity, and widely vary in their degree of difficulty.

Item Development Process

AzMERIT items go through a rigorous review before they are operational. When an item is "operational" it means it is used to determine a student's score on the assessment. This is a description of the process every item must go through before it is operational on AzMERIT.



Sample tests are available online for the math portion of AzMERIT. For more information view the Guide to the Sample Tests at http://azmeritportal.org/.

Test Construction Guidelines

The construction of the AzMERIT assessment is guided by the depth and rigor of the Arizona College and Career Ready Standards. Items are created to address key components of the standards and assess a range of important skills. The AzMERIT Blueprint provides an overview of the distribution of items on the AzMERIT according to the standards. The standards for Math Practices are embedded within all AzMERIT items. Further, the AzMERIT blueprint outlines the Depth of Knowledge distribution of items.

Math Practices

The standards for Mathematical Practice highlight the knowledge, skills and abilities that should be developed in students at all grades. The Mathematical Practices are a part of each course description for Grades 3 through 8, Algebra I, Geometry, and Algebra 2. These practices are a vital part of the curriculum. These skills are often difficult to measure, and as a result, every item created for AzMERIT aligns to one or more of the following eight Mathematical Practices.

Math Practice (MP)	Description
Math Practice 1	**Make sense of problems and persevere in solving them.** Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

Math Practice (MP)	Description
Math Practice 2	**Reason abstractly and quantitatively**. Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
Math Practice 3	**Construct viable arguments and critique the reasoning of others.** Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

Math Practice (MP)	Description
Math Practice 4	**Model with mathematics.** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
Math Practice 5	**Use appropriate tools strategically.** Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

Math Practice (MP)	Description
Math Practice 6	**Attend to precision.** Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.
Math Practice 7	**Look for and make use of structure.** Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well-remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.
Math Practice 8	**Look for and express regularity in repeated reasoning.** Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

Blueprint

The AzMERIT blueprints detail specific information in regard to the domains tested at each grade level. The blueprint outlines the percentage of points aligned to each domain.

	Domain	Minimum	Maximum
Algebra 1	Algebra	40%	44%
	Functions	36%	40%
	Statistics	17%	21%

Approximately 70% of the assessment for High School will be on major content.

	Domain	Minimum	Maximum
Geometry	Congruence	23%	27%
	Similarity, Right Triangles, And Trigonometry	27%	31%
	Circles, Geometric Measurement and Dimensions	23%	27%
	Modeling with Geometry	17%	21%

Approximately 70% of the assessment for High School will be on major content.

	Domain	Minimum	Maximum
Algebra 2	Algebra	34%	38%
	Functions	32%	36%
	Statistics	27%	31%

Approximately 70% of the assessment for High School will be on major content.

Depth of Knowledge (DOK)

DOK refers to the level of rigor or sophistication of the task in a given item, designed to reflect the complexity of the AzCCRS. Items at DOK level 1 focus on the recall of information, such as definitions, terms, and simple procedures. Items at DOK 2 require students to make decisions, solve problems, or recognize patterns; in general, they require a greater degree of engagement and cognitive processing than items at DOK 1. Items at DOK 3 feature higher-order cognitive tasks that assess students' capacities to approach abstract or complex problems.

Percentage of Points by Depth of Knowledge (DOK) Level			
High School	DOK Level 1	DOK Level 2	DOK Level 3
	10% - 20%	60% - 70%	12% - 30%

For more information on DOK go to www.azed.gov/AzMERIT.

Calculators

Calculators are permitted for both the paper-based and computer-based assessment for High School Math.

Item Formats

The AzMERIT Assessments are composed of item formats that include traditional multiple-choice response items and technology-enhanced response items (TEI). TEIs are computer-delivered response items that require students to interact with test content to select, construct, and/or support their responses. TEIs are better able to assess a deeper level of understanding.

Currently, there are nine types of TEIs that may appear on the High School Math computer based assessment for AzMERIT:

- Editing Tasks (ET)
- Editing Task Choice (ETC)
- Equation Editor (EQ)
- Graphic Response Item Display (GRID)
- Hot Text (HT)
    - Selectable Hot Text
    - Drag-and-Drop Hot Text
- Matching Item (MI)
- Multi-Select (MS)
- Open Response
- Table Item (TI)

For paper based assessments (including those for students with an IEP or 504 plan that specifies a paper based accommodation), TEIs will be modified so that they can be scanned and scored electronically or hand-scored.

See the table below for a description of each TEI. In addition, for examples of each response item format described, see the AzMERIT Training Tests at http://azmeritportal.org/.

Item Format	Description
Editing Task (ET)	The student clicks on a highlighted word or phrase that may be incorrect, which reveals a text box. The directions in the text box direct the student to replace the highlighted word or phrase with the correct word or phrase. For paper-based assessments, this item type may be replaced with another item type that assesses the same standard and can be scanned and scored electronically.
Editing Task Choice (ETC)	The student clicks a highlighted word or phrase, which reveals a drop-down menu containing options for correcting an error as well as the highlighted word or phrase as it is shown in the sentence to indicate that no correction is needed. The student then selects the correct word or phrase from the drop-down menu. For paper-based assessments, the item is modified so that it can be scanned and scored electronically. The student fills in a circle to indicate the correct word or phrase.

Item Format	Description
Equation Editor (EQ)	The student is presented with a toolbar that includes a variety of mathematical symbols that can be used to create a response. Responses may be in the form of a number, variable, expression, or equation, as appropriate to the test item. For paper-based assessments, this item type may be replaced with a modified version of the item that can be scanned and scored electronically or replaced with another item type that assesses the same standard and can be scanned and scored electronically.
Graphic Response Item Display (GRID)	The student selects numbers, words, phrases, or images and uses the drag-and-drop feature to place them into a graphic. This item type may also require the student to use the point, line, or arrow tools to create a response on a graph. For paper-based assessments, this item type may be replaced with another item type that assesses the same standard and can be scanned and scored electronically.
Hot Text (HT)	**Selectable Hot Text -** Excerpted sentences from the text are presented in this item type. When the student hovers over certain words, phrases, or sentences, the options highlight. This indicates that the text is selectable ("hot"). The student can then click on an option to select it. For paper- based assessments, a "selectable" hot text item is modified so that it can be scanned and scored electronically. In this version, the student fills in a circle to indicate a selection.
	Drag-and-Drop Hot Text - Certain numbers, words, phrases, or sentences may be designated "draggable" in this item type. When the student hovers over these areas, the text highlights. The student can then click on the option, hold down the mouse button, and drag it to a graphic or other format. For paper-based assessments, drag-and-drop hot text items will be replaced with another item type that assesses the same standard and can be scanned and scored electronically.
Matching Item (MI)	The student checks a box to indicate if information from a column header matches information from a row. For paper-based assessments, this item type may be replaced with another item type that assesses the same standard and can be scanned and scored electronically.
Multi-Select (MS)	The student is directed to select all of the correct answers from among a number of options. These items are different from multiple-choice items, which allow the student to select only one correct answer. These items appear in the online and paper-based assessments.
Open Response	The student uses the keyboard to enter a response into a text field. These items can usually be answered in a sentence or two. For paper-based assessments, this item type may be replaced with another item type that assesses the same standard and can be scanned and scored electronically.

Item Format	Description
Table Item (TI)	The student types numeric values into a given table. The student may complete the entire table or portions of the table depending on what is being asked. For paper-based assessments, this item type may be replaced with another item type that assesses the same standard and can be scanned and scored electronically.

Arizona's College and Career Ready Standards (AzCCRS)

Functions

Building Functions (F-BF)

HS.F-BF.A – Build a function that models a relationship between two quantities.

HS.F-BF.B – Build new functions from existing functions.

Interpreting Functions (F-IF)

HS.F-IF.A – Understand the concept of a function and use function notation.

HF.F-IF.B – Interpret functions that arise in applications in terms of the context.

HS.F-IF.C – Analyze functions using different representations.

Linear, Quadratic & Exponential Models (F-LE)

HS.F-LE.A – Construct and compare linear, quadratic, and exponential models and solve problems.

HS.F-LE.B – Interpret expressions for functions in terms of the situation they model.

Trigonometric Functions (F-TF)

HS.F-TF.A – Extend the domain of trigonometric functions using the unit circle.

HS.F-TF.B – Model periodic phenomena with trigonometric functions.

HS.F-TF.C – Prove and apply trigonometric identifies.

High School Math Item Specifications (Functions)

Building Functions

Content Standards	AzCCRS.Math.Content.F-BF.A.1 Write a function that describes a relationship between two quantities. AzCCRS.Math.Content.F-BF.A.1b Combine standard function types using arithmetic operations.		
Explanations	Students will analyze a given problem to determine the function expressed by identifying patterns in the function's rate of change. They will specify intervals of increase, decrease, constancy, and, if possible, relate them to the function's description in words or graphically.		
Content Limits	This standard is aligned to Algebra II only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	1, 2, 3, 4, 5, 6, 7, 8

Sample Task Demands	Common Item Formats	Recommended Math Practices
Students will be required to perform arithmetic operations to write one function that models a context for another.	• Equation Response • Multiple Choice Response	1, 2, 4, 5, 7, 8
Students will be required to create a multi-faceted function to model a context.		1, 2, 3, 4, 5, 6, 7, 8

Content Standards	AzCCRS.Math.Content.F-BF.A.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.		
Explanations	An explicit rule for the nth term of a sequence gives an as an expression in the term's position n; a recursive rule gives the first term of a sequence, and a recursive equation relates an to the preceding term(s). Both methods of presenting a sequence describe an as a function of n.		
Content Limits	This standard is aligned to Algebra II only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	4, 5, 8

Sample Task Demands	Common Item Formats	Recommended Math Practices
Students will be required to identify a formula that models a geometric or arithmetic pattern.	• Equation Response • Multiple Choice Response	4, 5, 8
Students will be required to translate a recursive function to an explicit formula.		4, 5, 8
Students will be required to create a recursive function to model a geometric pattern described verbally.		4, 5, 8

Content Standards	AzCCRS.Math.Content.F-BF.B.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.		
Explanations	Students will apply transformations to functions and recognize functions as even and odd.		
Content Limits	Algebra I: Linear, quadratic, square and cube root, piece-wise (Lin, Quad, Exp, PW) Algebra II: Polynomial, rational, radical, exponential, logarithmic, trigonometric (Poly, Rat, Rad, Log, Trig)		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	4, 5, 7

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to show the effects of a transformation by translating a graph.	• Equation Response • Graphic Response • Multiple Choice Response	4, 5, 7
Students will be required to determine the value of k from two related functions or graphs.		4, 5, 7
Students will be required to create a function to model a transformation of a given graph.		4, 5, 7
Students will be required to describe the effects of k on a transformation of a function.		4, 5, 7

Content Standards	AzCCRS.Math.Content.F-BF.B.4 Find inverse functions. AzCCRS.Math.Content.F-BF.B.4a Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.		
Explanations	None		
Content Limits	This standard is aligned to Algebra II only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is missing.	**Math Practices**	2, 4, 5, 7

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to create a function to model the inverse of a given function.	• Equation Response • Graphic Response • Multiple Choice Response	2, 4, 5, 7
Students will be required to select which function(s) does or does not have an inverse.		2, 4, 5, 7
Students will be required to graph the inverse of a function.		2, 4, 5, 7

Interpreting Functions

Content Standards	AzCCRS.Math.Content.F-IF.A.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).		
Explanations	The domain of a function given by an algebraic expression, unless otherwise specified, is the largest possible domain.		
Content Limits	This standard is aligned to Algebra I only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	2

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to recognize functions.	• Multiple Choice Response • Matching Item Response • Multi-Select Response • Proposition Response • Table Response	2
Students will be required to create or complete examples of functions and nonfunctions.		2
Students will be required to explain why a relation is or is not a function.		2

Content Standards	AzCCRS.Math.Content.F-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.		
Explanations	The domain of a function given by an algebraic expression, unless otherwise specified, is the largest possible domain.		
Content Limits	This standard is aligned to Algebra I only. Linear, quadratic, and exponential functions		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	2

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to recognize and identify input or output values from the table of a function.	• Equation Response • Graphic Response • HotText Response • Multiple Choice Response • Table Response	2
Students will be required to recognize correct uses of function notation.		2
Students will be required to complete a table of input and output values for a given function.		2
Students will be required to interpret statements that use function notation in terms of a context.		2

Content Standards	AzCCRS.Math.Content.F-IF.A.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.		
Explanations	None		
Content Limits	Algebra I: Linear or exponential Algebra II: Quadratic Limit sequence representations to rational values		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	8
Sample Task Demands		**Common Item Formats**	**Recommended Math Practices**
Students will be required to construct a function to model a sequence.		• Equation Response	8

Content Standards	AzCCRS.Math.Content.F-IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.		
Explanations	Students may be given graphs to interpret or produce graphs given an expression or table for the function, by hand or using technology.		
Content Limits	Algebra I: Linear, quadratic, exponential (with domains in the ingeters), square and cube roots, piece-wise (Lin, Quad, Exp) Algebra II: Polynomial, exponential, logarithmic, trigonometric (Poly, Rat, Rad, PW, Log, Trig) Key features may also include domain and range		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	2, 4, 5, 6

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to identify an interval on a graph where the function is increasing or decreasing.	• Equation Response • Graphic Response • Multiple Choice Response	2, 4, 5
Students will be required to identify intercepts of a function.		2, 4, 5
Students will be required to construct the graph of a linear function with a given verbal description for the intercept and/or slope.		2, 4, 5
Students will be required to identify key features, such as relative maximums and minimums, symmetries, and end behavior, of graphs and tables in terms of the quantities.		2, 4, 5
Students will be required to create a linear function with the same slope but different y-intercept (Algebra I only).		2, 4, 5, 6
Students will be required to create an exponential function that grows at a different rate than a given one.		2, 4, 5, 6
Students will be required to describe the meaning of key features of a function.		2, 4, 5, 6

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.</td></tr>
<tr><td>Explanations</td><td colspan="3">Students may explain orally, or in written format, the existing relationships.</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra I only.</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>2, 4, 6</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to create a graph with a given domain.</td><td rowspan="3">• Equation Response
• Graphic Response
• Multiple Choice Response</td><td>2, 4</td></tr>
<tr><td colspan="2">Students will be required to determine the domain of the given graph of a function.</td><td>2, 4, 6</td></tr>
<tr><td colspan="2">Students will be required to determine the domain of a given function based on context.</td><td>2, 4, 6</td></tr>
</table>

Content Standards	AzCCRS.Math.Content.F-IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.		
Explanations	The average rate of change of a function y = f(x) over an interval [a,b] is $\Delta y/\Delta x=(f(b)-f(a))/(b-a)$ In addition to finding average rates of change from functions given symbolically, graphically, or in a table, Students may collect data from experiments or simulations (ex. falling ball, velocity of a car, etc.) and find average rates of change for the function modeling the situation.		
Content Limits	Algebra I: Linear, quadratic, exponential (with domains in the integers), square and cube root, piece-wise (Lin, Quad, Exp) Algebra II: Polynomial, exponentialradical, logarithmic, trigonometric (Poly, Rat, Rad, PW, Log, Trig)		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	2, 4, 5

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to estimate the average rate of change of the graph of a given function over a given interval.	• Equation Response • Multiple Choice Response	2, 4, 5
Students will be required to calculate the average rate of change of a function expressed symbolically or as a table over a given interval.		2, 4, 5
Students will be required to interpret the rate of change in context.		2, 5

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

AzCCRS.Math.Content.F-IF.C.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.</td></tr>
<tr><td>Explanations</td><td colspan="3">Key characteristics include but are not limited to maxima, minima, intercepts, symmetry, end behavior, and asymptotes.</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra I only.</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>5, 6</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to construct the graph of a function.</td><td rowspan="2">• Equation Response
• Graphic Response
• Multiple Choice Response</td><td>5, 6</td></tr>
<tr><td colspan="2">Students will be required to identify intercepts, maxima, and minima of a function from a graph.</td><td>5, 6</td></tr>
</table>

Content Standards	AzCCRS.Math.Content.F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. AzCCRS.Math.Content.F-IF.C.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.		
Explanations	Key characteristics include but are not limited to maxima, minima, intercepts, symmetry, end behavior, and asymptotes.		
Content Limits	This standard is aligned to Algebra I only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	5, 6
Sample Task Demands		**Common Item Formats**	**Recommended Math Practices**
Students will be required to construct the graph of a function.		• Graphic Response • Multiple Choice Response	5, 6

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

AzCCRS.Math.Content.F-IF.C.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.</td></tr>
<tr><td>Explanations</td><td colspan="3">Key characteristics include but are not limited to maxima, minima, intercepts, symmetry, end behavior, and asymptotes.</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra II only.

Choices to selected response items should be differentiated with different zeros, max/mins, and/or end behavior</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>5, 6</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to construct the graph of a function.</td><td rowspan="2">• Graphic Response
• Multiple Choice Response</td><td>5, 6</td></tr>
<tr><td colspan="2">Students will be required to identify end behavior from the graph of a function.</td><td>5, 6</td></tr>
</table>

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

AzCCRS.Math.Content.F-IF.C.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.</td></tr>
<tr><td>Explanations</td><td colspan="3">Key characteristics include but are not limited to maxima, minima, intercepts, symmetry, end behavior, and asymptotes.</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra II only.</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>5, 6</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to construct the graph of a function.</td><td rowspan="3">• Equation Response
• Graphic Response
• Multiple Choice Response</td><td>5, 6</td></tr>
<tr><td colspan="2">Students will be required to identify end behavior or intercepts from the graph of a function.</td><td>5, 6</td></tr>
<tr><td colspan="2">Students will be required to identify or show period, midline, and amplitude.</td><td>5, 6</td></tr>
</table>

Content Standards	AzCCRS.Math.Content.F-IF.C.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. AzCCRS.Math.Content.F-IF.C.8a Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. AzCCRS.Math.Content.F-IF.C.8b Use the properties of exponents to interpret expressions for exponential functions.		
Explanations	None		
Content Limits	HSF-IF.C.8a is aligned to Algebra I only. Functions in one form must be given to students, who are then expected to write these functions in different forms HSF-IF.C.8b is aligned to Algebra II only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	2, 7
Sample Task Demands		**Common Item Formats**	**Recommended Math Practices**
Students will be required to create an equivalent function in a specific form that reveals characteristics of the function defined by that expression.		• Equation Response • Multiple Choice Response • Proposition Response	2, 7
Students will be required to interpret parameters of a function in terms of the context.			2, 7

Content Standards	AzCCRS.Math.Content.F-IF.C.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).		
Explanations	None		
Content Limits	Algebra I: Linear, quadratic, square and cube root, piece-wise, exponential (with domains in the integers) (Lin, Quad, Exp) Algebra II: Polynomial, exponential, logarithmic, trigonometric (Poly, Rat, Rad, Log, Trig)		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	6, 7

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to compare numeric values representing properties of two functions.	• Equation Response • Graphic Response • Multiple Choice Response	6, 7
Students will be required to compare two functions qualitatively.		6, 7
Students will be required to construct a graph of a function for which a given comparison with another function is true.		6, 7

Linear, Quadratic & Exponential Models

Content Standards	AzCCRS.Math.Content.F-LE.A.1 Distinguish between situations that can be modeled with linear functions and with exponential functions. AzCCRS.Math.Content.F-LE.A.1a Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. AzCCRS.Math.Content.F-LE.A.1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. AzCCRS.Math.Content.F-LE.A.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
Explanations	Students can investigate functions and graphs modeling different situations involving simple and compound interest. Students can compare interest rates with different periods of compounding (monthly, daily) and compare them with the corresponding annual percentage rate. Spreadsheets and applets can be used to explore and model different interest rates and loan terms.
Content Limits	This standard is aligned to Algebra I only.
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.

Context	Context is allowed.	**Math Practices**	3, 4, 5, 7, 8

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to create a value or expression to show how a function grows over equal intervals.	• Equation Response • Graphic Response • Multiple Choice Response	4, 5, 7, 8
Students will be required to identify situations that represent linear growth.		3, 5, 7, 8
Students will be required to identify situations that represent exponential growth.		3, 5, 7, 8

Content Standards	AzCCRS.Math.Content.F-LE.A.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).		
Explanations	None		
Content Limits	Algebra I: Constructing linear and exponential functions in simple context (not multi-step) Algebra II: Solving multi-step problems by constructing linear and exponential functions		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	4, 8

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to create an equation of a linear function passing through two given points.	• Equation Response	4, 8
Students will be required to create an equation of a linear function given a graph of that function.		4, 8
Students will be required to create an equation of a linear function given a description of that function.		4, 8

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-LE.A.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.</td></tr>
<tr><td>Explanations</td><td colspan="3">None</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra I only.</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>2</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to compare two or more functions for values over various intervals given graphs or other representations of the functions.</td><td rowspan="2">• Equation Response
• Multi-Select Response</td><td>2</td></tr>
<tr><td colspan="2">Students will be required to solve problems based on the fact that exponential functions grow/decay faster than linear or quadratic functions.</td><td>2</td></tr>
</table>

Content Standards	AzCCRS.Math.Content.F-LE.A.4 For exponential models, express as a logarithm the solution to ab to the ct power = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.		
Explanations	None		
Content Limits	This standard is aligned to Algebra II only.		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	7

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to evaluate a logarithm.	• Equation Response	7
Students will be required to create an exponential equation equivalent to a logarithmic equation.		7
Students will be required to create a logarithmic equation equivalent to an exponential equation.		7

Content Standards	AzCCRS.Math.Content.F-LE.B.5 Interpret the parameters in a linear or exponential function in terms of a context.		
Explanations	None		
Content Limits	Algebra I: exponential functions limited to those with domains in the integers Algebra II: Exponential functions with domains not limited to integers		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	2, 4
Sample Task Demands		**Common Item Formats**	**Recommended Math Practices**
Students will be required to interpret the meaning of a parameter of a function.		• Multi-Select Response	2, 4
Students will be required to interpret the meaning of a parameter in a function that combines linear and exponential terms.			2, 4

Trigonometric Functions

Content Standards	AzCCRS.Math.Content.F-TF.A.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.		
Explanations	None		
Content Limits	This standard is aligned to Algebra II only. Positive angles, all four quadrants of the coordinate plane		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	
Sample Task Demands		**Common Item Formats**	**Recommended Math Practices**
Students will be required to determine the radian measure of an angle.		• Equation Response • Graphic Response • Proposition Response	
Students will be required to construct an angle with a given radian measure.			
Students will be required to explain the relationship of the central angle to the arc.			

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-TF.A.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.</td></tr>
<tr><td>Explanations</td><td colspan="3">Students may explain (orally or in written format) their understanding.</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra II only.
Sine and cosine, common angles</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>2</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to evaluate trigonometric functions for common angles and their co-terminal angles.</td><td rowspan="2">• Equation Response
• Graphic Response</td><td>2</td></tr>
<tr><td colspan="2">Students will be required to place a point on the unit circle to show trigonometric values with given radian measures.</td><td>2</td></tr>
</table>

Content Standards	AzCCRS.Math.Content.F-TF.B.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.		
Explanations	None		
Content Limits	This standard is aligned to Algebra II only. Sine and cosine functions are used for modeling simple harmonic motion		
Common Item Formats	The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.		
Context	Context is allowed.	**Math Practices**	4, 5, 7

Sample Task Demands	**Common Item Formats**	**Recommended Math Practices**
Students will be required to determine the amplitude of a given sine or cosine function.	• Equation Response	4, 5, 7
Students will be required to create the trigonometric function with given numeric values for amplitude, midline, and frequency.		4, 5, 7
Students will be required to create a trigonometric function given a verbal description.		4, 5, 7

<table>
<tr><td>Content Standards</td><td colspan="3">AzCCRS.Math.Content.F-TF.C.8 Prove the Pythagorean identity sin2(theta) + cos2(theta) = 1 and use it to find sin(theta), cos(theta), or tan(theta) given sin(theta), cos(theta), or tan(theta) and the quadrant of the angle.</td></tr>
<tr><td>Explanations</td><td colspan="3">None</td></tr>
<tr><td>Content Limits</td><td colspan="3">This standard is aligned to Algebra II only.</td></tr>
<tr><td>Common Item Formats</td><td colspan="3">The Item Formats section on pages 11 through 13 provides a list of item formats that may be used to assess this standard. The common item formats include but are not limited to those shown with the sample task demands.</td></tr>
<tr><td>Context</td><td>Context is allowed.</td><td>Math Practices</td><td>3</td></tr>
<tr><td colspan="2">Sample Task Demands</td><td>Common Item Formats</td><td>Recommended Math Practices</td></tr>
<tr><td colspan="2">Students will be required to determine the value of a trigonometric function using the Pythagorean identity.</td><td rowspan="2">• Equation Response
• Hot Text Response</td><td>3</td></tr>
<tr><td colspan="2">Students will be required to order steps in a proof of the Pythagorean identity.</td><td>3</td></tr>
</table>